



# Robust Spectral Features for Emotion Recognition using GMM and SVM with PCA

S. Radha Krishna, R. Rajeswara Rao,

**Abstract:** In this paper, the research work investigated on various spectral accents, for example, M.F.C.C, pitch-chroma, skew-ness, and centroid for feeling acknowledgment. For the test arrangement, the feelings considered in this investigation are Fear, Anger, Neutral, and Happy. The framework is assessed for different blends of spectral accents. At last, it makes sense of the blend of MFCC and skewness gave a superior acknowledgment execution when contrasted with different mixes. The previously mentioned accents are inspected utilizing Gaussian Mixture models (G.M.M.s) and Support Vector Machines (S.V.M.s). To expand the framework execution and evacuate insignificant data shape the recently produced vigorous accents, in this paper investigated an approach, namely Principal Component Analysis (PCA) is utilized to expel high dimensional information. It was set up that the acknowledgment execution for include sets in the wake of applying PCA got expanded in both grouping models utilizing GMMs and SVMs. The general framework is perceived 35% preceding PCA 58.3% later than PCA utilizing GMMs, and 28% preceding PCA, 50.5% later than PCA utilizing SVMs. The database utilized as a part of this examination is Telugu feeling speech corpus (IIT-KGP)

**Keywords:** Gaussian Mixture Models (GMM.s), Principal Component Analysis (P.C.A), Mel Frequency Cepstral Coefficients (M.F.C.C).

## I. INTRODUCTION

Discourse remains the most normal type of feeling acknowledgment. Utilizing discourse flag, we can without much of a stretch pass on our inclination to human's contrasted with different ways. The current research work is working on discourse acknowledgment framework to enhance the human PC cooperation. Presently the people can keep up the nearby connection with a machine by utilizing machine learning and example acknowledgment methods. Feelings assume a critical part in human discernment and basic leadership [1]. A feeling is a creature condition of psychological conduct which communicates the inclination by physical minutes or by tackle.

As the material minutes are the makeover development beside the non-verbal communication, styles are the method they talk and the way they articulate the words. People are great at concealing the emotions from others at that specific circumstance people couldn't pass judgment on at what express the individual is truly in,

however, in the discourse, people can, by the profession of a word and the accentuations of a specific letter. In the event that they demonstrate to cover up likewise, they couldn't work as much as long as they need, sooner or later they could be gotten, in this manner taking the framework to do on discourse is the best and best need.

Gone ahead by works in supposition analysis, this exploration work investigates ways to deal with the programmed location of feelings from the discourse. The nearness of feeling advances discourse more characteristic. Human aims are broadly communicated in discourse utilizing feelings. A Fitting feeling is valuable to pass on the message in various. The current research work is going on discourse acknowledgment framework to enhance the human PC cooperation. Ways.

In numerous applications, Emotion acknowledgment gives input data to distinguish the human state. An Automatic Emotion acknowledgment framework is characterized as a framework in which related feeling is distinguished from the given discourse articulation. The pattern of globalization and the unavoidable prevalence of the web focus on the requirement for the capacities of human-PC association strategies. It can likewise be actualized in the fields of telephonic correspondences in call communities for understanding the individual's states of mind and responding as indicated by it. As a component of regular correspondence, People expresses feelings, Motion, outward appearances, activities, and prosodies, or some blend of signals used to judge the feelings of people. Feelings are additionally enunciated by composed writings. An unmistakable use of feeling acknowledgment framework happens in numerous fields like crime scene investigation for distinguishing and mental examinations, understanding and breaking down individual's feelings for either treating them medicinally or finding if the individual is coming clean or not in specific cases. As feeling acknowledgment framework is an example acknowledgment undertaking, accent extraction is a noteworthy advance in feeling acknowledgment process. In this paper, the spectral accents of the discourse are considered. The Spectral analysis includes dissecting the normal sound range of the human voice. For a specific sound source, it gives certain data about the circulation of vitality as a component of frequency.

Manuscript published on 30 September 2019

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# Robust Spectral Features for Emotion Recognition using GMM and SVM with PCA

Spectral accents speak to vocal tract data, for example, organize frequencies, consecutive variety in shapes/sizes of vocal tracts, spectral transfer speeds, spectral move off. The examination work has considered four distinct kinds of spectral accents, for example, MFCC, pitch chroma, centroid, and skewness. Directed diverse trials on different blends of Spectral accents, it is set up that the mix of MFCC and Skewness have given a superior feeling acknowledgment execution as far as rate when contrasted with different mixes [2]. Because of this turning point result settle on a choice to consider the blend of spectral accents MFCC and Skewness for additionally look into the usage and furthermore regard this accents as the Robust accents and furthermore work connected PCA calculation on this Robust element for enhancing the framework exactness by grouping models SVM and GMM. This paper is composed as takes after Section 1 presented the feeling acknowledgment framework... Segment 2 clarifies the system, area 3 delineates different spectral accents, and segment 4 shows GMM and its modeling for feeling acknowledgment on Spectral accents. Segment 5 depicts how PCA calculation functioned in the framework; Section 6 talked about exploratory assessment setup database utilized for the investigation and the consequences of the framework. At last, Section 7 gives a conclusion.

## II. METHODOLOGY

### 2.1 Stimulation of work

Feeling Recognition from Speech, for the most part, has three working advances which are Feature Extraction, Training, and Testing as appeared in Figure 1. Passionate discourse acknowledgment has an essential concern on three goals. The main target is to offer a best in a class record of the accessible, passionate discourse information accumulations. The number of enthusiastic states, the dialect, the number of speakers, and the sort of discourse is immediately tended to. The second goal is to take in the most well-known acoustic accents utilized for passionate discourse acknowledgment and to assess how the enthusiastic impacts them. Specific characteristics are the Mel-frequency Cepstral coefficients, the tumult of the address flag, the pitch, the discourse rate, the formants, the vocal tract cross-segment regions, and the vitality administrator based accents. The tertiary target is to review appropriate techniques in the general population field to order discourse into enthusiastic states. We take a gander at divisions characterization techniques that undertaking timing data from which that disregard it. Gathering techniques in light of covered k-closest neighbors, straight separate analysis, shrouded Markov models, fake neural systems, support vector machines are continued running over.

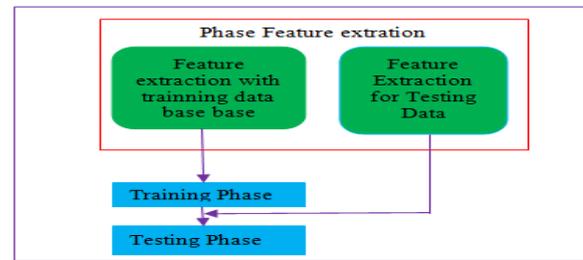


Figure 1: Pattern Recognition Task

### 2.2 Extrication of features

Extraction of a accents which are dependable and the primary errand for this kind of a frameworks, In the component extraction organize it will extricate two datasets one is the preparation information and the testing information, preparing information will exist alongside the information, and the accents which are separated are contrasted and the accents which are removed in the testing information with the order model and finishes up the feeling of a test discourse document which was given to the framework to test. Figure 2 depicts the extraction of accents from the speech.

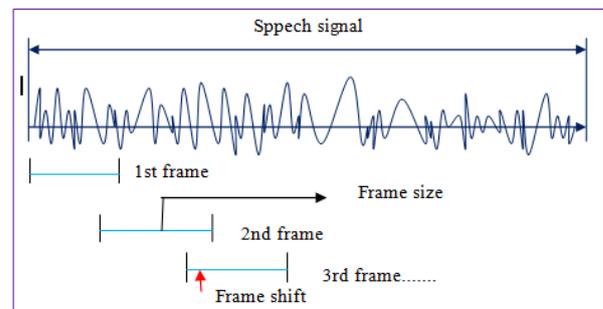


Figure 2: Feature extraction from a speech signal

The most widely recognized ways to deal with programmed feeling acknowledgment depend on expression level prosodic accents [3]. Late examinations have demonstrated that articulation level insights of segmental spectral accents likewise contain rich data about expressivity and feeling. Feeling Recognition from the discourse is an imperative research territory, which expects to know the enthusiastic condition of human from his or her discourse wave flag. To appraise a client's feelings by the discourse flag, we need to choose powerful accents. In this paper, spectral accents are removed from the discourse flag. The Spectral accents assume an imperative part in Emotion Recognition utilizing discourse. The fundamental goal of this work is to enhance the framework execution, i.e., with separate of the level of precision in every feeling independently distinguished by the framework. For this reason, we utilized PCA for lessening the measurement of the element vector. The overall procedure of the system depicts in Figure 3.

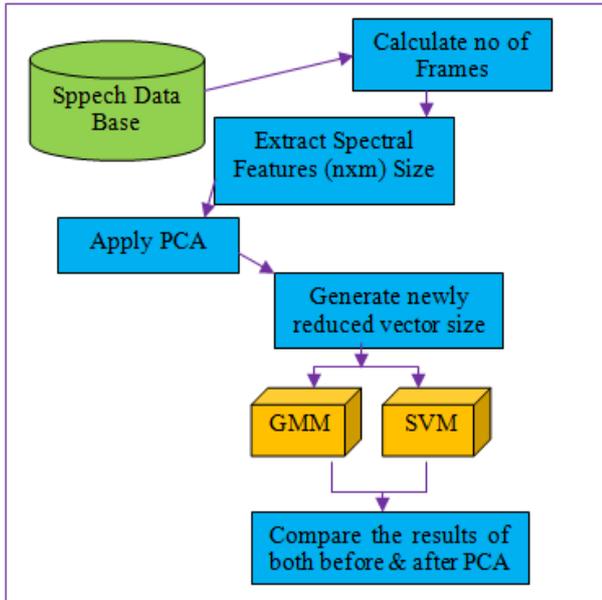


Figure 3: Methodology of the proposed Emotion Recognition System

### III. SPECTRAL FEATURES

Accent choice is a standout amongst the essential Pre preparing for perceiving the feelings from the discourse flag [4]. The Spectral accents assume a critical part in Speech Emotion Recognition. In the focused on discourse, the vocal tract range is balanced coming about changes in a general range. The Spectral shape accents are the accents processed from brief time Fourier change of the flag. A casing by-outline analysis is performed utilizing a window estimate 20ms and move 10ms.

#### 3.1 MFCC

The Mel-frequency Cepstral coefficients (MFCCs) are the portrayal of the transient power range of a sound, in light of a direct cosine change of a log control range on a nonlinear Mel size of frequency [5]

[6]. Figure 4.explains about MFCC stages.

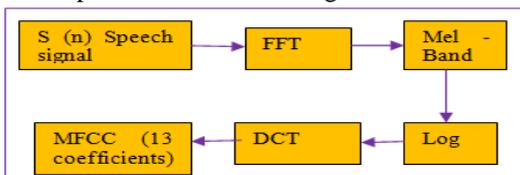


Figure 4: Mel-frequency Cepstral coefficients (MFCCs)

#### 3.2 Spectral Centroid

Spectral Centroid is a decent indicator of the brilliance of sound. It is utilized as a part of computerized sound flag handling. It is a measure utilized as a part of an advanced flag preparing to describe a range. It is figured as a weighted mean of the frequencies display in the flag decided to utilize FFT with their extents and weights. The favorable fundamental position of Spectral centroid is it can recognize the surmised area of formants [7].

#### 3.3 Skewness

Skewness is the measure of high frequencies exhibit in a flag by and large. High frequencies are acquired in light of the pitch of the tone. In talking pitch, dependably assumes a noteworthy part in recognizing the feeling. Skewness shows

more vitality on the higher and lower parts of the range. Along these lines, skewness depends on both pitch and vitality. That is the motivation behind why it is decided for feeling location in our trial [8] [9] [10] [11]. The principle preferred standpoint of Skewness is, it demonstrates the vitality of a range in light of positive and negative Skewness.

#### 3.4 Pitch Chroma

Chroma portrays the edge of pitch turn as crosses the helix. Two octave-related pitches will have a similar edge in the Chroma circle, a connection that isn't caught by a direct pitch scale. It portrays the edge of pitch revolution, and Chroma accents are powerful to commotion and clamor [6]. Concentrate the powerful spectral accents from the given database and identify which include blends gives the best exactness that is called as strong accents

### IV. MODELING THE EMOTION RECOGNITION SYSTEM

Introduce inquire about works were finished by utilizing a distinctive order model for characterizing the in general and individual acknowledgment rate of the framework. The momentum explores work in this paper utilized DSVM and GMM arrangement strategies with include measurements diminishment and without accent measurements lessening by utilizing PCA.

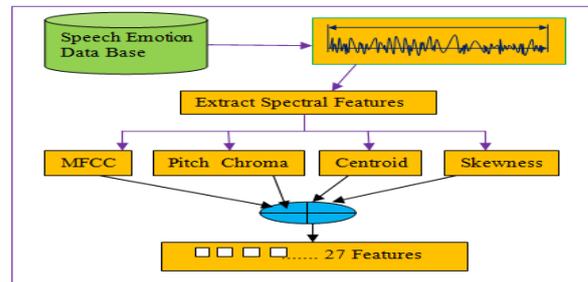


Figure 5: Spectral Features Extraction Process

#### 4.1 GMM

GMM is one of the noticeable factual methodologies for modeling in this paper. We have modeled spectral accents utilizing GMM. The GMM protest actualizes the desire expansion (EM) calculation for the fitting mixture of Gaussian models.[10][12][13].For every feeling, one GMM has been made amid the preparation stage utilizing 30 seconds of discourse span testing is completed by assessing the probabilities. The feeling which gives the most extreme likelihood is announced as a distinguished feeling.

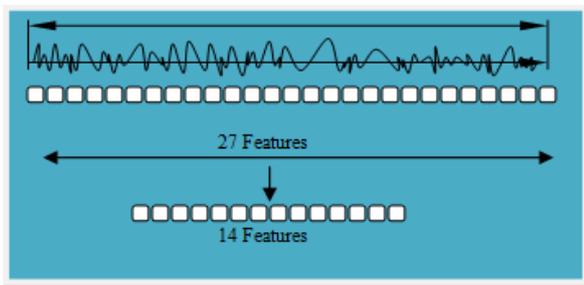
#### 4.2 SVM

Among the current strategies, we have picked an approach called Dendo graph Based Support Vector Machine (DSVM). The proposed DSVM model holds the upside of both the calculation of the ascendant progressive grouping technique (AHC) of classes and the effective twofold order in SVM.

Despite the fact that DSVM needs (K-1)SVMs for K-class issues in the preparation stage, for the testing stage DSVM requires an ideal arrangement of SVMs chose descendant from the foundation of the scientific classification through the chose class among the "leaf" hubs. DSVM strategy that we propose comprises of two noteworthy advances: First, calculation of bunches for classes known. Second is partner an SVM at every hub of the scientific classification got by groups from the initial step. How about we make an arrangement of tests  $x_1, x_2, \dots, x_n$  marked every one by  $y_i \in \{c_1, c_2, \dots, c_k\}$ ,  $k$  is the number of classes ( $k \leq n$ ). The initial step of DSVM strategy comprises figuring  $k$  gravity places for the  $k$  known classes. At that point, AHC bunching is connected over these  $k$  focuses. DSVM gives a hint of arrangement of  $x$  which is SVM1 ->SVM1.2 ->SVM1.2.2. We can see that the grouping system is more ideal with DSVM than the other multi-class SVM and gives an exceptional answer for the example  $x$ .

The outcomes acquired by testing, spectral accents MFCC, Pitch Chroma, Spectral Centroid, and Skewness is broke down. The same number of blends of the accents are tried constantly we have a result that for the mix of MFCC and skewness better precision esteems are acquired in the greater part of the cases. And furthermore, testing has been finished by taking estimations of Gaussians in the range 2, 4, 8, 16, 32 and 64. By watching the got comes about w.r.t - Gaussian incentive for all blends, we have presumed that as Gaussian esteem 16 a normal of good effectiveness is shown.

Along these lines, further research is proceeded by thinking about the mix of M-F-C-C and skewness with Gaussian esteem 16. The same is portrayed in the diagrammatic arrangement beneath Fig 6.



**Figure 6: MFCC+Skewness Feature Vector Size**

### V. PRINCIPAL COMPONENT ANALYSIS

PCA is generally utilized as a device in exploratory information explanatory reasoning and for making prescient models. Should be possible by Eigenvalue deterioration of an information covariance (or connection) lattice or one of a kind esteem breaking down of an information grid, as a rule after mean thinking (and normalizing or using Z-scores) the information network for each quality. The consequences of a PCA are typically examined regarding constituent scores, once in a while called factor scores and masses.

Independent Component Analysis (ICA) and PCA square measure measurable task that uses asymmetrical transmutation to drive a meeting of articulations of perhaps corresponded factors into a meeting of estimations of straight unrelated factors known as principal parts [4]. The amount of

primary parts isn't precisely or resembling the number of ace factors. This interpretation is unnatural such the start principal element has the largest conceivable distinction that's, represents but a lot of the unevenness within the data as might be expected, and every succeeding element, thus, has the foremost astounding amendment potential underneath the limitation that it's symmetrical to the foregoes parts. The next vectors square measure associate degree unrelated symmetrical premiseset. PCA is the most uncomplicated of the real eigenvector-based variable diagnostic reasoning. Frequently, its task is thought of as revealing the inward structure of the data in a very method that best reasons the distinction within the data. With in the event that a variable data assortment is notional as a meeting of ordinates in a very high-dimensional information house (1 hub for each factor), PCA will provide the shopper a glare dimensional film, a projection or "shadow" of this objective once saw from its (in some sense; see beneath) most lighting up perspective. this can be finished by utilizing simply the initial number of essential parts with the goal that the spatial property of the deciphered data is diminished. During this work, PCA and ICA square measure utilized to feelings [4]. This PCA has connected the two instances of getting ready and testing accent vectors. This could be trailed by this below calculation. Discourse accent vector to lessen the dimensionality of the element vector and for better putting the clients[14],[15].

### 5.1 PCA Algorithm for Selecting Robust Features:

#### Preparation Phase:

- 1). To all feelings E-j from feeling list N do
- 2). To all discourse flag S-i of feeling E-J
- 3). To each example of S-i from K, tests do
- 4). Compute M.F.C.C accents f-k from S-i
- 5). Compute SKEWNESS accents S-k from S-i
- 6). link SKEWNESS with M.F.C.C
- 7). end
- 8). end
- 9). Introduce P.C.A calculation and assess  $\mu_j$ , combined fluctuation

$$\frac{\sum_{i=1}^k \lambda_{ii}}{\sum_{i=1}^n \lambda_{ii}} \quad (1)$$

- 10). Register the lessened network.
- 11). Introduce G M M typical limits mean  $\mu$  and fluctuation  $\sigma^2$ .
- 12). Prepare a decreased list of capabilities for ideal arrangement utilizing EM calculation
- 13). End

#### Testing Phase:

- 1). To all feelings E-j from feeling index N do
- 2). To all discourse flag S-i of feeling E-J
- 3). To each example of S-i from K, tests do
- 4). Compute M.F.C.C accents f-k from S-i

- 5). Compute SKEWNESS accents S-k from S-i
- 6). Link SKEWNESS with M.F.C.C
- 7). End
- 8). close
- 9). PCA calculation and assess  $\mu_j$ , the total change

$$\frac{\sum_{i=1}^k \lambda_{ii}}{\sum_{i=1}^n \lambda_{ii}} \quad (2)$$

- 10).for each model ( $\lambda_1:\lambda_2:\lambda_3:\lambda_4$ )
- 11). for each example of S-i from K tests do
- 12). discover likelihood (Px )w.r.t every feeling
- 13). discover max of (Px) and decide the feeling
- 14). End.

### 5.2 Data given as input

Information separated from accent extraction methods is put away in different organizers for accommodation. Every envelope contains isolate information which can be given as a contribution as per prerequisite. Information is removed independently for every feeling and put away as a lattice. And furthermore, information is separated sex savvy for giving preparing and testing terms. Along these lines, there exists a whole arrangement of information that can be given a contribution to PCA calculation. As we have considered 30 Sec of prepare term and we acquire networks of size (1111)x(14) for preparing. 14 are the number of accents. We have considered 3- Sec of trail length, in this way, a framework of size (111)x(14) is gotten.

As we have talked about PCA requires an m-X-n framework as information, and it restores an m-X-p grid as yield where p is a number littler than n. Thusly which a component decrease is conceivable. As we talked about PCA calculation is utilized for diminishing accents or lessen the span of the network here likewise a similar method we took after. When we are given (1111)x(14) size component vector lattice to PCA calculation, it lessened the size to (1111)x(12) and the same concerning testing additionally (111)x(14) vectors into (111)x(12). Considered the outcome as a contribution to the GMM model arrangement for recognizing the feelings of users' s[14],[15]. This appears in Fig.7.

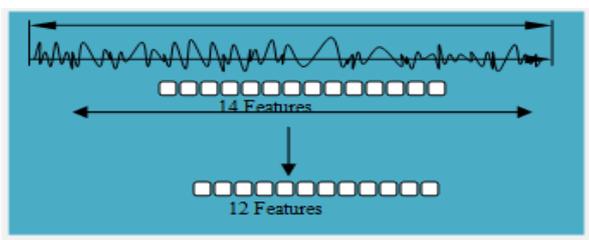


Fig.7. Vector size reduction by using PCA

## VI. RESULTS DISCUSSION

This section contains various subsections for examining the feeling acknowledgment in for all intents and purposes. In this work led the trials Spectral accents of all extraordinary combinational accents separated from all mixes MFCC+Skewness have given great outcomes. So itself, it calls it as a powerful element for perceiving feelings. The

entire analyses have done on a Telugu discourse corpus passionate database. This segment gives full execution insights about the framework took after by forbidden qualities and relating charts.

### 6.1 Experimental DataBase

In this work, the discourse database utilized is the acted-influence Telugu database. The expectation of a database is vital to perceive the feeling of discourse viably. The discourse corpus, IITKGP-SESC, utilized as a part of this examination, was recorded utilizing 6 (3 male and three females) proficient specialists from Vijayawada All India Radio (AIR), India. The specialists worked in this database were exceptionally experienced. They all are around 25-40 years of age and had the expert experience of 8-12 years. 15 semantically impartial Telugu sentences considered in dissecting the feelings. Every one of the craftsmen needed to talk the 10 sentences in 4 given feelings in a single session. Ten sessions considered in setting up the database. There are absolutely 2400 quantities of articulations in the database was (10 sessions  $\times$  10sentences  $\times$  4emotions  $\times$  6artists). Every feeling had 640 expressions. The aggregate length of the database was around 36 minutes. The four feelings considered for gathering the proposed discourse corpus were: Anger (A), Fear (F), Happiness (H), and Neutral (N). The preparation span 30 seconds, and the testing length of 3 seconds was considered for testing the framework.

### 6.2 Experimental Setup

In this work, MATLAB R2012b is used to perform experiments on Windows XP stage.

### 6.3 Results

The spectral accents reflected as a contribution for the P.C.A calculation are 14 in quantity. In the wake of applying P.C.A they are diminished to 12. The outcomes acquired are dissected, and certain deductions are gotten that the precision estimations of the feeling acknowledgment have been extensively expanded. The explanation behind the expansion in the exactness can be supported as P.C.A is an established factual strategy for changing characteristics of a dataset into another arrangement of uncorrelated traits called principal components (PCs). P.C.A can be utilized to decrease the dimensionality of an informational index[14],[15], while as yet holding however, much of the changeability of the dataset as could be expected. High dimensional information can act issues for machine learning like prescient models in view of such information risk overfitting. Moreover, a significant number of qualities might be repetitive or profoundly corresponded, which can likewise prompt a corruption of expectation exactness.

Amid the procedure, as we hold the qualities with the most extreme total difference the lessened change esteems hold the whole data with a superior portrayal which can be useful in enhancing the precision of the qualities in the wake of applying PCA.

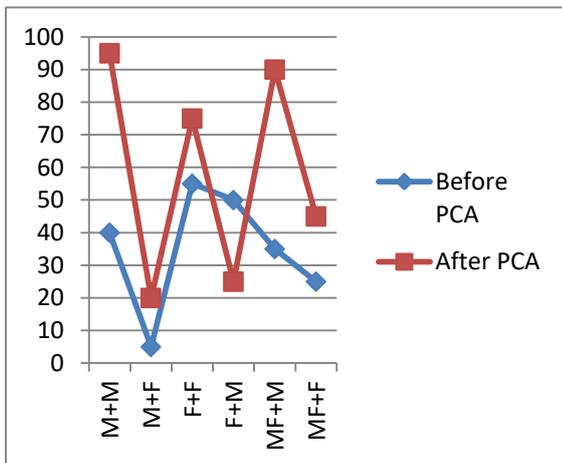
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A similar framework with diminished qualities is given as a contribution to both GMM and SVM for grouping. When PCA Obtained estimations of correctness's are classified as takes after comparing with charts.

From every one of the speaker's blend comes about was found with two distinctive order procedures. After the outcome analyzed this exploration work make sense of that utilizing high dimensional calculation was got better comes about contrasted with normal classification these outcomes expresses that PCA is the best practice to enhance the framework exactness and furthermore enhance the framework quality administration. All the comparing comes about is plotted in table 1, table 2and for the pictorial portrayal we demonstrated the outcomes as in Graph1, Graph 2.

**Table 1: The result for all combinations of speakers earlier and later than PCA using GMM Classification Model.**

Speakers Combinations	EARLIER THAN PCA	LATER THAN PCA
M+M	40%	95%
M+F	5%	20%
F+F	55%	75%
F+M	50%	25%
MF+M	35%	90%
MF+F	25%	45%

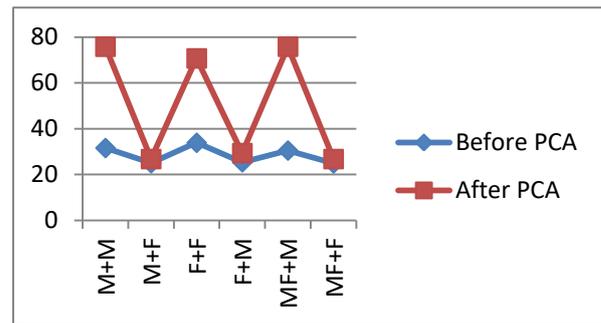


**Graph 1: depicts that later than PCA we got better performance of the system.**

**Table 2: Result for all combinations of speakers earlier and later than PCA using SVM Classification Model**

Speakers Combinations	EARLIER THAN PCA	LATER THAN PCA
M+M	31.60%	75.80%
M+F	25.00%	26.80%
F+F	33.90%	70.70%
F+M	25.40%	29.40%
MF+M	30.50%	75.80%

MF+F	24.90%	26.80%
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**Graph 2: Depicts that later than PCA we have enhanced the performance of the system using SVM**

## VII. CONCLUSION

This exploration work is intended to locate a vigorous arrangement of accents for programmed content free Emotion Recognition framework utilizing GMM and SVM. For this reason, an approach called Principal component analysis has been considered. The capabilities are decreased utilizing this approach and in this way, acquired diminished capabilities are broken down and tried utilizing GMM and SVM. The outcomes got with a diminished list of capabilities are contrasted against the outcomes and unreduced qualities. It has been distinguished that exactness of acknowledgment has been enhanced by utilizing the diminished capabilities with the level of precision took by earlier than PCA 35%, later than PCA 58.3% in the wake of utilizing GMM and earlier than PCA 28%, later than PCA 50.5% utilizing SVM. At long last, this work reasoned that lessening high dimensional information will enhance the framework execution and quality. Subsequently, the resultant feature set can call as robust features.

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